Unit 9 – Atomic Models & Periodic Trends

0.2 You consistently make meaningful contributions to the class' online space. (Digital citizenship)

Proficient: *The student makes at least two meaningful postings to the class' online space each week during the marking period and has a total of 27 postings by the end of the marking period. A meaningful posting includes, but is not limited to, a well thought out question that the student would like answered, a detailed answer to another student's question, a well thought out comment on another student's posting, and/or an annotated link to a website or movie that will aid others in understanding the material being learned.*

Advanced: *The student makes at least 4 meaningful postings to the online space each week during the marking period and has at least 40 total postings by the end of the marking period.*

9.1 You can draw and interpret various atomic and molecular models (Models)

Proficient: *The student can correctly draw and explain the major improvements included in each of the atomic models presented in the unit. The student can explain how a given scientist's model improved on the one that came before it, and the student can outline the process through which the scientist arrived at his model.*

Advanced: *The advanced student can apply the processes used by each scientist to describe and explain the kinds of experimental data that would be obtained in a novel situation. The student can also explain why a given model fails to correctly predict the outcome of a given experiment.*

9.2 You can use various systems to model the electron configuration of an atom or ion. (Electron Configuration)

Proficient: *Proficiency is achieved by correctly listing the electron configuration, drawing an orbital diagram showing the position of electrons in a set of orbitals or drawing an electron dot diagram for an element which has electrons in "s, p or d" orbitals that follows all of the basic rules given in the unit.*

Advanced: *An advanced grade is awarded when a student can correctly list the electron configuration, draw an orbital diagram or a dot diagram for an element which has electrons in "f" orbitals, or an element whose electron configuration deviates from the standard set of rules.*

9.3 You are able to predict ion charge, atomic radius, ionic radius, and other properties based on periodic trends. (Periodic Trends)

Proficient: *The proficient student is capable of correctly predicting an element's chemical and physical properties based on the element's position on the periodic table. The student is also able to compare the properties of elements in the same family or in the same period.*

Advanced: *The student achieving an advanced grade will also understand and apply exceptions to the general rules. The student is also capable of comparing elements that are located in different families and periods.*

9.4 You are able support your predictions about element reactivity based on periodic trends with experimental data. (Peri Trends Lab)

Proficient: *The proficient student is capable of correctly predicting an element's reactivity based on the element's position on the periodic table. The student is also able exhibit a basic understanding of how experimental data collected on an element's reactivity supports or refutes these predictions.*

Advanced: *The student achieving an advanced grade will be able to demonstrate the skills described for the proficiency level, and will also be able to provide a more in-depth explanation of how their results demonstrate the patterns outlined by periodic trends. Advanced students will also be able to provide competent explanations for any "wrong" data, as well as how to potentially fix these mistakes in the future.*

Notes:

Notes:

Chemistry - Unit 9 Sticky Tape Activity

Part 1 – Preparing the tapes - examining their behavior

1. Take a 15 cm piece of transparent tape and make a handle on the end by folding under the first cm of tape, sticky side to sticky side. Place this tape on the lab table. This is the base tape.

2. Take a second 15 cm piece of transparent tape, make a handle as before, and place this tape on top of the base tape. Label this tape "B" for bottom.

3. Attach a third similarly prepared strip of tape onto the bottom tape. Label this tape "T" for top.

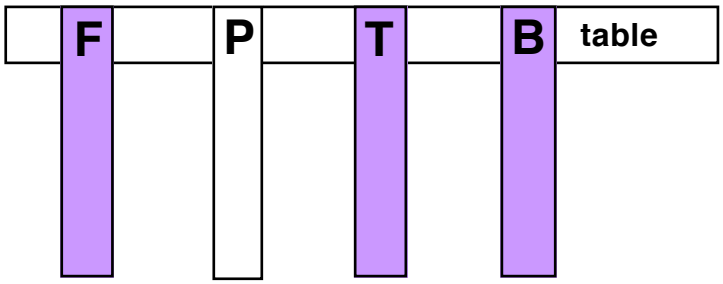
4. Repeat steps 1 through 3 above. You now have two sets of 3-layer tapes.

5. Obtain 2 pieces of paper, the same dimensions as the tapes, and hang one from the edge of the table. Label the hanging paper "P." Approach the hanging paper with the other piece of paper. *Describe what you see.*

6. Obtain 2 pieces of aluminum foil, the same dimensions as the tapes, and hang one from the edge of the table. Label the hanging foil "F." Approach the hanging foil with the other piece of foil. *Describe what you see.*

7. Peel one set of T and B tapes from its base tape, keeping the T and B tapes together. Run your finger down the non-sticky side, then quickly peel them apart.

8. Hang each strip next to the hanging paper and foil.



9. Repeat step 7 with the other set of tapes.

10. With a T tape hanging from one hand and a B tape hanging from the other, experiment by approaching each of the hanging tapes, the foil strip and the strip of paper. *Be sure to describe the kind of interaction you see as you bring each of the tapes near the hanging tapes and strips.*

	Top	Bottom	Foil	Paper
Top				
Bottom				
Foil				
Paper				
Plastic				
(Other)				

Part 2 - The assignment of (+) and (-) charges

After you have summarized your findings (attraction, repulsion or no interaction) for the two tapes, foil and paper, rub a hard rubber or plastic rod with fur or wool. Approach the T tape, the B tape, the foil and the paper with the rod. *Describe what you see. Does the rod behave more like the T tape or the B tape?*

Based on a number of observations scientists have assigned the label of negative (–) to the charge of a rubber or plastic rod rubbed with fur or wool. The fur or wool becomes positively charged (+). Based on your observations from using the rod, label the T and B tapes as either a (+) or (–).

Now, reflect on the relative strengths of the interactions between the tapes, foil and paper. How did attraction between the T or B tape and the foil or paper compare to the interaction between tapes? You may need to repeat step 10 to answer this question.

Chemistry – Unit 9
Contributions to the Development of Models of the Atom

For this assignment, you will be doing some research about scientists who contributed to our current understanding of the atom. There are many scientists whose discoveries paved the way for all of us who study chemistry. You will work in groups of two or three and will be assigned one such scientist to research.

Ultimately, your goal is to write a brief story of the contribution to the development of a model of the atom that your scientist made in a way that your group can present to the rest of the class.

For each of the following scientists state

1. the problem with the previous model
2. the experimental design used (if any)
3. the evidence (data) that led to a change in the previous model
4. how each scientist developed a new atomic model that
   a. incorporated the new evidence OR
   b. resolved a flaw in the previous model

You should also find out some interesting tidbits about the scientist's life and weave those into the story you are telling about your assigned contributor. This is the one opportunity you have in chemistry to be colorful, so take advantage of it!

Three class periods will be devoted to preparing your story. The first day will be spent gathering information and the other two days will be spent completing your story and presentation. On the fourth day, all groups will tell their story to the class and we will create a timeline of contributions and we will trace the "model" of the atom through its historical development.

You will be graded on the quality of your written work and accompanying diagrams as well as how well you know your story. During the presentations of other groups, you will be expected to pay attention, take notes and contribute to this whole class discussion.

Scientists:

Niels Bohr
Sir James Chadwick
Robert Millikan
Henry Moseley
Ernest Rutherford
J.J. Thomson

Notes:

Notes:

Thomson to Rutherford: *New Experiments, New Ideas, New Models*

Go to http://www.mhhe.com/physsci/chemistry/essentialchemistry/flash/ruther14.swf
Watch and listen to the flash animations.

1. What does Thomson's model look like? Draw a picture below

2. Why is it called the "plum pudding" model? What name would you give this model?

3. What did Rutherford expect to see in his experiment? What should alpha particles do when they go through atoms if Thomson's model is correct?

4. What did Rutherford actually see in his experiment?

5. What new idea does Rutherford bring to the atom?

6. How does Rutherford's model explain the backward reflection of alpha particles?

Bohr's Model: *Colors of the Rainbow*

The sun gives off white light, a mixture of ALL colors, a full spectrum. Where do these colors come from? What causes them? This lab should enable you to develop your own theory about the source of color.

Procedure:

Turn the power source with the element inside on. Use extreme caution!! The power source provides over 5000 Volts.

Observe the color of the light with your naked eye. Record this data in the table. Use the diffraction grating and the emission tube to observe and record the spectra. Pay close attention to the colors produced and their location in the spectrum. Also note the colors that are absent. Record this data in the table.

Data:

Source or Element	Color seen by the naked eye	Spectrum as seen through the grating			
		700 nm	600 nm	500 nm	400 nm
Overhead fluorescent light					
Incandescent Bulb					
CFL bulb					
Hydrogen					
Helium					
Argon					

Questions:

1. Which color has the most energy? Which has the least energy?

2. When an atom spits out colored light, what are the electrons doing?

3. Draw a picture of Bohr's model of the atom.

4. How many electrons are allowed in each energy level of the Bohr Model? Fill in the table to the right:

Energy Level	Maximum # of electrons allowed
1	
2	
3	

5. How is Bohr's model better than Rutherford's model?

6. Why does each different element produce a different spectrum?

7. How does Bohr's model of the atom explain the colors made by excited atoms?

Classwork: *Isotopes & Ions*

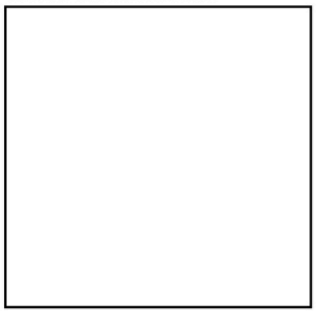
Name: _____

Symbols:

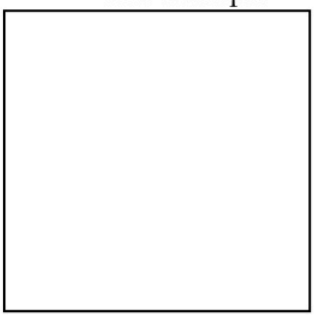
(n) Neutron (−) Electron (+) Proton

Using the symbols shown to the left, draw the atoms, isotopes and ions indicated in each question.

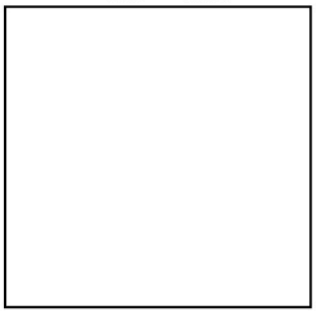
1. Helium Atom



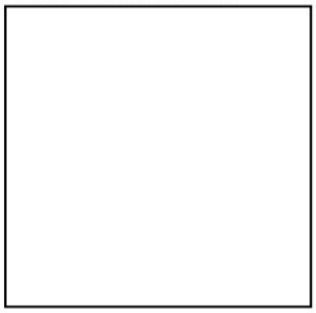
^{3}He Isotope



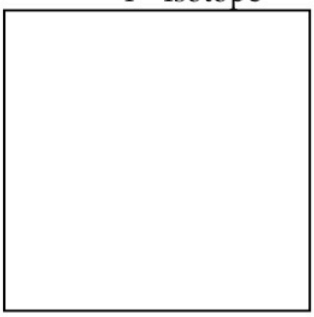
$^{4}He^{+2}$ Ion



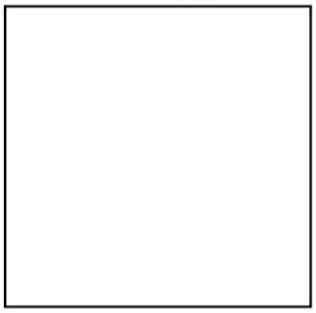
2. Fluorine Atom



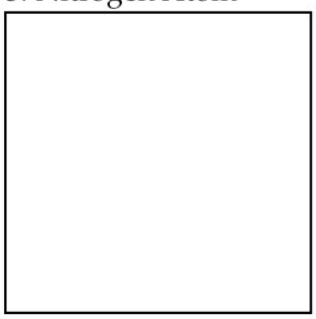
^{20}F Isotope



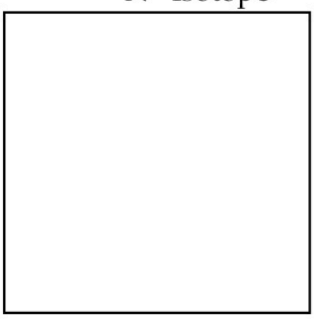
$^{19}F^{-1}$ ion



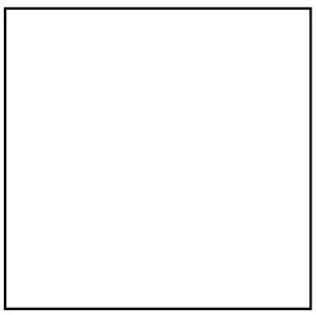
3. Nitrogen Atom



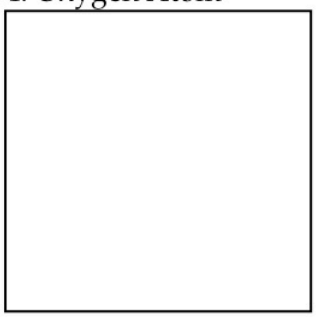
^{12}N Isotope



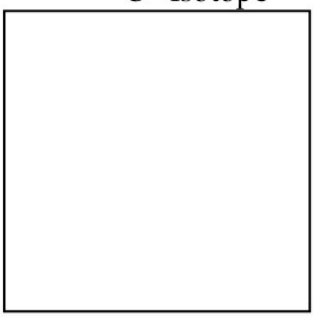
$^{14}N^{+3}$ Ion



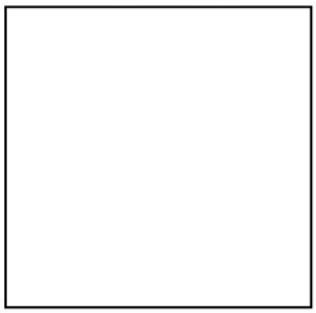
4. Oxygen Atom



^{18}O Isotope



$^{16}O^{-2}$ Ion



Worksheet: Subatomic Particles

1. Li^{+1}

Name of the element:	_____
Is it an ion?	_____
Number of electrons:	_____
Number of protons:	3
Number of neutrons:	4
Atomic Number:	_____
Atomic Mass:	_____

2. P^{-3}

Name of the element:	_____
Is it an ion?	_____
Number of electrons:	18
Number of protons:	_____
Number of neutrons:	_____
Atomic Number:	_____
Atomic Mass:	_____

3. V^{0}

Name of the element:	_____
Is it an ion?	_____
Number of electrons:	_____
Number of protons:	_____
Number of neutrons:	_____
Atomic Number:	23
Mass Number:	51

4. Mg^{+2}

Name of the element:	_____
Is it an ion?	_____
Number of electrons:	_____
Number of protons:	12
Number of neutrons:	_____
Atomic Number:	_____
Mass Number:	24

5. Ba^{+4}

Name of the element:	_____
Is it an ion?	_____
Number of electrons:	_____
Number of protons:	56
Number of neutrons:	82
Atomic Number:	_____
Mass Number:	_____

6. U^{-5}

Name of the element:	_____
Is it an ion?	_____
Number of electrons:	97
Number of protons:	_____
Number of neutrons:	146
Atomic Number:	_____

7. Cl^{-1}

Name of the element:	_____
Is it an ion?	_____
Number of electrons:	_____
Number of protons:	_____
Number of neutrons:	20
Atomic Number:	_____
Mass Number:	37

8. Pb^{+2}

Name of the element:	_____
Is it an ion?	_____
Number of electrons:	_____
Number of protons:	82
Number of neutrons:	126
Atomic Number:	_____
Mass Number:	_____

Worksheet: *Lewis Dot Structures*

Name: _____

Draw the following molecules using Lewis Dot diagrams.

1. LiF

2. CaI_2

3. PH_3

4. K_2O

5. S_2

6. C_2H_4

7. SiO_2

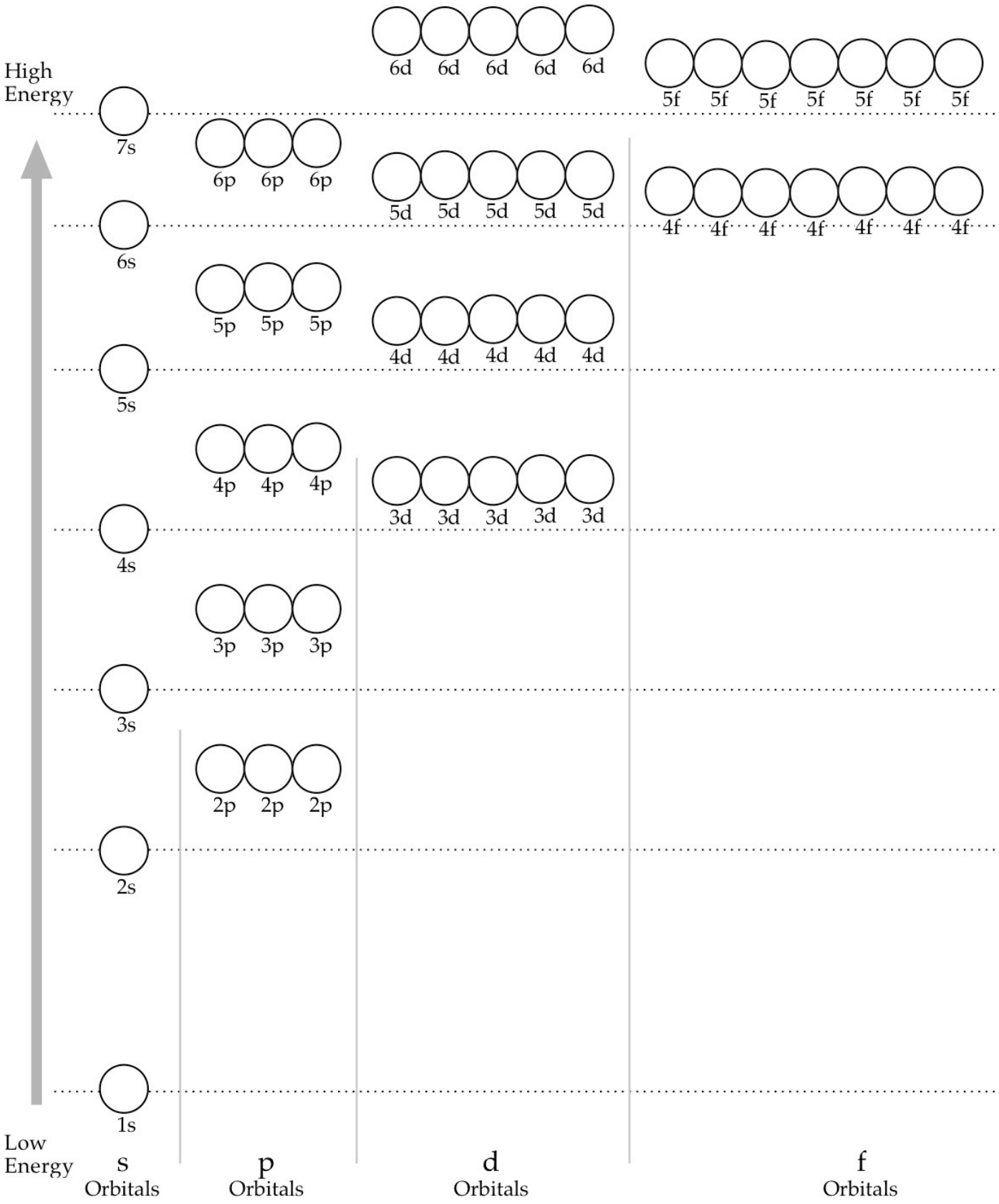
8. HCN

9. Na_2O_2

10. MgF_2

11. Se_2Br_2

12. N_2F_4


High Energy
7s
6p 6p 6p
6d 6d 6d 6d 6d
5f 5f 5f 5f 5f 5f 5f
5d 5d 5d 5d 5d
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6s
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p Orbitals
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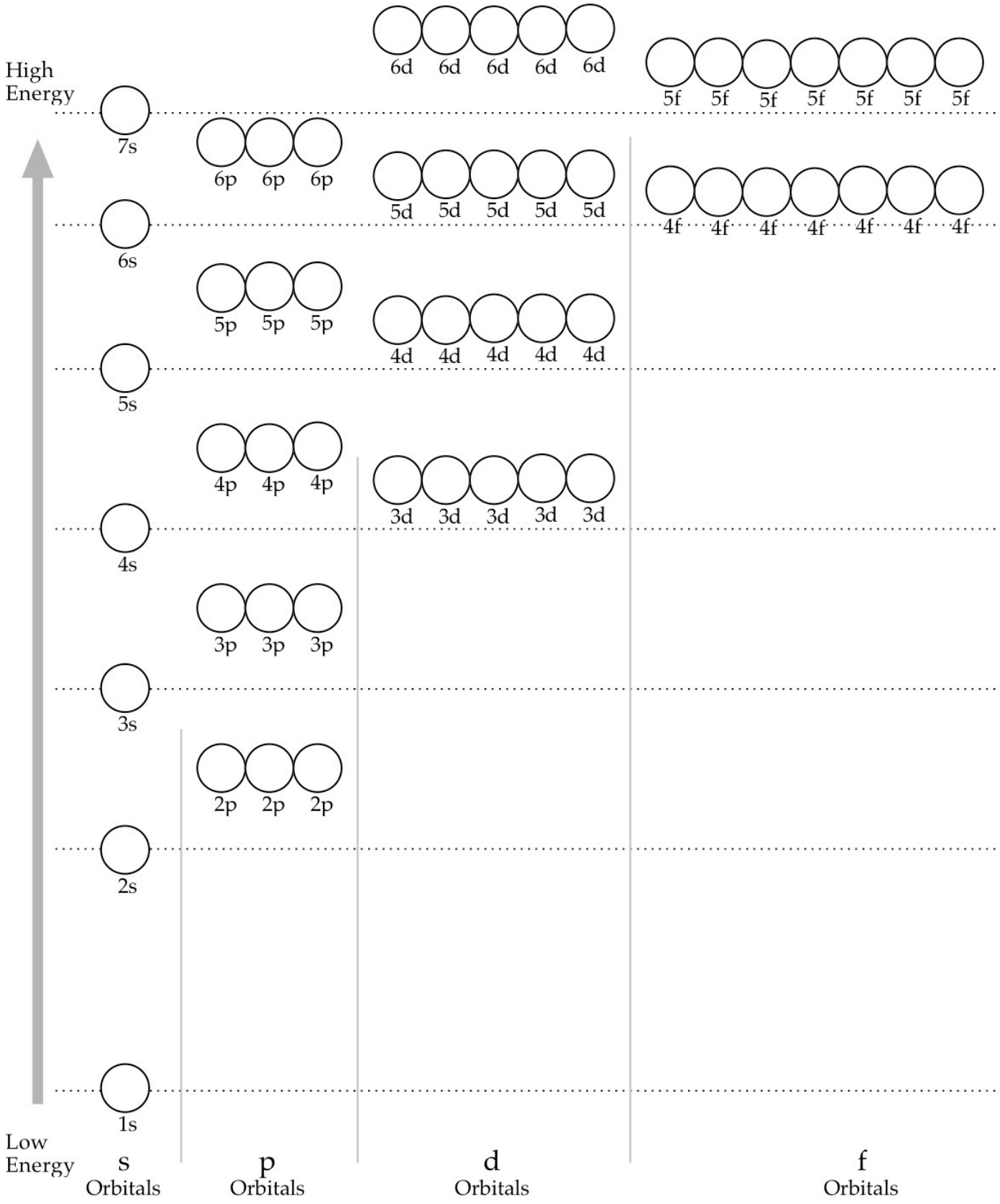
f Orbitals


High Energy
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3s
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2s
1s
Low Energy
s Orbitals
p Orbitals
d Orbitals
f Orbitals

Lab: *Chemical Trends in Families and Periods*

Objective

To understand how chemical families behave and react and to understand how the chemical reactions of elements changes as you move down a family and across a period.

The following elements will be used in this lab:

Sodium	**Magnesium**				**Chlorine**
Potassium	**Calcium**	**Iron**	**Copper**	**Zinc**	**Bromine**
					Iodine

Which of these elements are metals?

Which of these elements are nonmetals?

Predictions

1. In this lab you will react all of the metals listed above with water. Some will react quickly and violently. Some will react very slowly if at all.

    a. Which of the metals listed above will exhibit the most violent reaction with water?

    b. Explain your reasoning:

    c. Which metals will react most slowly?

    d. Explain your reasoning:

2. Do you expect to see more variation in the reactivities of metals as you go across a period or down a family? Explain your answer.

3. In Part II of this lab you will be testing the reactivities of the halogens with each other.

    a. Which halogen listed above do you expect to be most reactive?

    b. Explain your reasoning.

Procedure/Data Collection/Questions

Sodium**	**Magnesium**				**Chlorine**
Potassium**	**Calcium**	**Iron**	**Copper**	**Zinc**	**Bromine**
					Iodine

**Your teacher will demonstrate these for you. Be sure to copy down the data.

Part I: Metal Reactivities

A. Reaction of Metals with water

1. Place approximately equal chunks of the metals into beakers filled with approximately the same amount of water. Record the approximate "chunk size" and the approximate amount of water in your data table. Be descriptive enough to allow someone else to repeat your procedure.

2. Begin timing each reaction when the metal hits the water. Record the time when you start seeing bubbles for each reaction. Make observations about each reaction. Stop timing after 5 minutes if nothing has happened. Record any interesting observations you make.

3. Save the contents of the test tube for part B

B. Reaction with Phenolphthalein (Use materials from step A)

1. In each of the beakers from Part A, place 3 drops of phenolphthalein.

2. Make observations about the reaction that occurs. Record these observations in your data table. The darker the pink color, the more basic the solution. Dark pink = high pH.

3. Empty the beakers and rinse them with water.

C. Reaction of metals with hydrochloric acid , HCl

1. Repeat Part A substituting the hydrochloric acid for water.

Questions

1. Make a statement about the reactivity of metals as you move across (left to right) the period 4 metals. Back up your statement with results from THIS LAB.

2. Make a statement about the reactivity as you move down the columns of the alkali metals and the alkaline earth metals. Back up your statement with results from THIS LAB.

3. How reactive will beryllium be will be with water? Barium? Explain your answer by referring to the results from THIS LAB.
4. Was the reactivity of the metals with hydrochloric acid GENERALLY greater or less than their reactivity with water? Offer an explanation using the concept of electron structure.

Part II: Halogen Reactivities

Safety Alert: Halogens have strong odors. Avoid breathing them

A. Testing the color of unreacted and reacted halogens in mineral oil

1. Your teacher will show you the color of each unreacted halogen when it is dissolved in mineral oil. *Record the color that each halogen shows when dissolved in mineral oil.*

2. Your teacher will show you the color of each reacted halide ion, chloride (Cl^-), bromide (Br^-), and iodide (I^-), by placing one dropper of NaCl, one dropper of KI and one dropper of NaBr solution into three different test tubes. *Record the color of each halide ion in your data table.*

B. Testing the reactivity of halogens

1. Combine each unreacted halogen with the other two reacted halide ions to see if a reaction will occur. (See Data Table) Place one dropper of NaBr into one test tube and one dropper of KI into another test tube. Add one dropper of chlorine water to each. Cork and shake. Then add one dropper of mineral oil, cork and shake again. When the mineral oil has separated, record its color in the Data Table and determine which halogen is present in the mineral oil. Use a data table similar to the one shown below to record your results.

DATA TABLE: Combinations of halogen and halide ions

	Cl_2	**Br_2**	**I_2**
NaCl	XXXXXXXXXXXXX XXXXXXXXXXXXX	color: unreacted halogen:	color: unreacted halogen:
NaBr	color: unreacted halogen:	XXXXXXXXXXXXX XXXXXXXXXXXXX	color: unreacted halogen:
KI	color: unreacted halogen:	color: unreacted halogen:	XXXXXXXXXXXXX XXXXXXXXXXXXX

Questions

5. Make a statement about the reactivity of halogens with each other as you move down the group. Back up your statement with results from THIS LAB.

6. Predict the reactivity of fluorine and justify your prediction.

Guided Worksheet: *Periodic Trends*

Name: _____

The periodic table that we have today is helpful because it contains patterns and trends which can tell us information about the atoms. In this exercise you are going to identify some of those patterns and trends.

1. As you go through the periodic table left to right and top to bottom, you can see that the elements are arranged in numerical order. What is the name of the number that they are arranged by?

_____

2. In the periodic chart, there is also a pattern involving the atomic masses.
   a) IN GENERAL, what happens to the atomic mass of atoms as you move from left to right and top to bottom in the periodic chart?

   b) There are at least three exceptions to this general rule. Identify at least one pair of atoms which break this general rule.

   _____ & _____

3. Recently we talked about the "most probable charge" that an atom will take when it becomes an ion.
   a) List all the families that are likely to take POSITIVE charges? _____

   b) List all the families that are likely to take NEGATIVE charges? _____

   c) Look at the families you have listed above and create a general rule that will help you, just by looking at the periodic table, to identify the charge an ion will take.

   d) Are there any exceptions to the rule you just made? (There should be!) Identify the exception...

4. As you move along the periodic chart, every time a proton is added to form a new atom an electron is also added.
   a) If you pick a family of atoms and move down the periodic chart from Period 1 to Period 7, what is happening to the atoms' valence electrons?

b) What is happening to the atom's radius (or size) as you move down the family from Period 1 to Period 7? Explain how you know.

c) As you move from left to right across a single period (from the alkali metals to the noble gases) atoms keep getting more electrons and more protons, but they also keep getting smaller. Suggest a reason why atoms would get more charges and decrease in size.

5. In the movie and in the lab, you saw that Alkali metals and Alkali earth metals react with water. As the atoms in these two families moved <u>down</u> the periodic table, they became more and more reactive.

a) Do the alkali metals and alkali earth metals want to gain or lose electrons when they react?

b) What happens to the size of the atom as you move down the chart?

c) When will the attraction between protons and electrons be the strongest? When they are close together or far apart?

c) Link your answers to Part A, Part B and Part C to explain why atoms in Family IA and IIA become more reactive as you move DOWN the chart.

6. Atoms in the Oxygen family and the atoms in the Halogen family are on the right side of the periodic chart. Their reactivity also depends on where they are on the chart. Use your answers to the following questions to find a pattern to their reactivity.

a) Do the halogens and oxygen family want to gain or lose electrons when they react?

b) What happens to the size of the atom as you move down the chart?

c) When will the attraction between protons and electrons be the strongest? When they are close together or far apart?

c) Link your answers to Part A, Part B and Part C to explain why atoms in Family VIA and VIIA become more reactive as you move UP the chart.

Classwork: *Patterns of Elements in the Periodic Table*

Name: _____

What patterns are there among atoms in the same family? As you move from the top of the table to the bottom of the table inside a single family describe what happens to the following physical and chemical properties:

Atomic number _____ as you move down a family.

Atomic mass _____ as you move down a family.

The number of valence electrons _____ as you move down a family.

The most likely charge _____ as you move down a family.

The atomic radius (size of the atom) _____ as you move down a family.

As you move down a family (look at the halogens!) atoms tend to move from _____ to _____
(fill in the blanks with the words "solid", "liquid" or "gas")

As you move down a family atoms tend to become _____ like metals.
(Look at Families 14 & 15)

What patterns are there among atoms in the same period? As you move from the left of the table to the right of the table inside a single period describe what happens to the following physical and chemical properties:

Atomic number _____ as you move to the right across a period.

Atomic mass _____ as you move to the right across a period.

The number of valence electrons _____ as you move to the right across a period.

The most likely charge _____ as you move to the right across a period.

The atomic radius (size of the atom) _____ as you move to the right across a period.

As you move to the right across a period (look at Period 4!) atoms tend to move from _____ to _____
(fill in the blanks with the words "solid", "liquid" or "gas")

As you move to the right across a period atoms tend to become _____ like metals. *(Look at Period 4 again.)*

Unit 9 Review: *Democritus, Dalton & Thomson*

Name: _____

1. How would Thomson explain what he found to Democritus?

2. Explain how Thomson came up with the "Plum Pudding" or "Fruit Jello" model.

3. What did Rutherford find that no one else had ever found?

4. Explain the experiment that lead Rutherford to his discovery.

5. Determine which person did or said each of the following. Write Dalton, Thompson, Rutherford, or Bohr on each blank.

_____ He discovered the electron.

_____ Atoms combine in distinct ratios or proportions

_____ The electrons travel around the nucleus in well defined paths like planets around the sun.

_____ The atom is made up mostly of space

_____ The nucleus consists of a dense center.

_____ He was the first to show that the atom could be divided into smaller parts (subatomic particles)

6. Write neutron, proton, or electron on each blank to match with the statement.

_____ This particle is the lightest of all the particles.
_____ This subatomic particle has no charge
_____ In an isotope the number of this subatomic particle changes
_____ When an atom becomes ionized, what is lost or gained?
_____ In an ion, atom, or isotope, this subatomic particle has the same number.
_____ In a neutral atom, the number of protons equals the number of what?
_____ The mass of the proton is almost equal to the mass of which subatomic particle?
_____ In a positive ion, the atom has lost which type of particle?
_____ The charge on an atom is determine by the number of valence _____.

7. Determine the number of valence electrons for each atom or ion below:

He _____ P _____

Li _____ B _____

Cl^{-1} _____ K^{+1} _____

8. Determine which of the following is a non-metal (N) or metal (M) or semi-metal (S).

Na _____ He _____
Cl _____ P _____
Au _____ O _____

9. Calculate the number of neutrons in the following:

Na _____ Be _____
O _____ ^{15}N _____
^{37}Cl _____ K^{+1} _____

10. Determine which atom is larger. Circle the larger atom.

Li or K F or O
Mg or K Cl or Br
Se or Kr

11. Determine which atom is more reactive. Circle the more reactive atom.

Li or Na Br or At
Mg or Sr Cs or Li
O or S

12. Determine the most likely charge on each atom. Write the atom with its charge designation (+3, +2, +1, 0, -1, -2, -3) on the blank.

Na	_____	Cl	_____
Ca	_____	Se	_____
B	_____	F	_____
He	_____		

13. Determine which element has the following properties.

_____1. The 3rd energy level contains 5 valence electrons

_____2. The 2nd energy level contains the valence electrons. When charged the atom has a most likely charge of +1

_____3. The 3rd energy level contains only 2 electrons in the s orbital

_____4. This element is in family VII and period 2.

_____5. The 2nd energy level contains 3 electrons in the p orbitals

O. Fill in the blanks for the following:

1. **Al**

_____	a.	atomic number	_____
_____	b.	atomic mass	_____
_____	c.	number of protons	_____
_____	d.	number of neutrons	_____
_____	e.	number of electrons	_____

2. **^{37}Cl**

_____	a.	atomic number	_____
_____	b.	Mass number	_____
_____	c.	number of protons	_____
_____	d.	number of neutrons	_____
_____	e.	number of electrons	_____

3. **Na^{+1}**

_____	a.	atomic number	_____
_____	b.	atomic mass	_____
_____	c.	number of protons	_____
_____	d.	number of neutrons	_____
_____	e.	number of electrons	_____